A proposed best practice approach to overcome unverified and unverifiable “first records” in ichthyology

by

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Abstract. – We propose here a best practice protocol to be followed by prospective authors of first record notes; it was prompted by the publication in scientific journals of several erroneous “first records”. This includes accurate checking of available regional fish diversity catalogues; designation and deposit of voucher specimen(s) in curated collections with proper information; inclusion of photograph(s), meristic and morphometric characters, and, whenever possible, DNA sequences (Barcoding) of the specimen(s). Examples are taken from the Mediterranean Sea. The responsibility of both scientific editors and reviewers in the publication process of first records is also discussed.

Résumé. – Proposition d’un protocole précis pour éviter les premiers signalements non vérifiés et non vérifiables en ichtyologie.

La publication récente de premiers signalements non vérifiés dans les journaux scientifiques nous a conduit à proposer un protocole précis à suivre par les auteurs. Ce protocole inclut la vérification effective des catalogues taxonomiques et des faunes ichtyologiques ; la désignation de spécimen(s) témoin(s) (“voucher”), leur dépôt dans des collections reconnues avec leurs informations afférentes ; la fourniture d’une (de) photographie(s), des caractères méristiques et morphométriques, et quand cela est possible, d’une séquence ADN (Barcoding) du (des) spécimen(s). Des exemples choisis sur des espèces méditerranéennes sont présentés. La responsabilité des éditeurs et des arbitres tout au long de la procédure de publication de premiers signalements est également abordée.

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In the last 25 years, several factors have contributed to the increase of new distributional records of marine species in the Mediterranean Sea. On the one hand they have been due to the actual modification of species distributions, i.e. bioinvasion of this sea by extra-Mediterranean organisms – either man-mediated or by natural range expansion – (e.g. Quignard and Tomasini, 2000; Galil, 2007) and species then spreading within the Mediterranean (e.g. Koukouras *et al*., 1998); these phenomena have been and still are quite extensive. On the other hand new records have also been published on previously unnoticed autochthonous species. These result in part from various scientific enhancements, including scientific surveys covering wide geographic ranges (e.g. Relini *et al*., 1999); the increased number of Mediterranean marine biologists that carry out surveys and publish the ensuing results, as there is a relationship between the number of scientists in a region and the accurate description of the regional biodiversity (e.g. Mora *et al*., 2008); and the rapidity and ease of publication in the internet by professional and amateur marine biologists. These new findings also result from the increased awareness of fishermen and of a large number of lay people who readily alert scientists about unusual findings (e.g. “The international CIESM jellywatch programme” launched in 2008 [Boero, 2013]).

The awareness of Mediterranean biodiversity and its recent changes have promoted, among other actions, the production of species catalogues (e.g. Relini, 2008, 2010) or monographs (e.g. Lipej and Dulčić, 2010). Indeed regional and global taxonomic catalogues have been important to scientists since the dawn of modern systematics (e.g. Linnaeus, 1735). However, the cataloguing action has acquired a new urgency through the fact that global biodiversity is changing and declining under multiple mounting threats.

This crucial issue, coupled with the overall increase of new records, has encouraged the appearance of a number of *ad hoc* journals dedicated, fully or partly, to biodiversity and biogeographical records in the marine realm, e.g. *Marine Biodiversity* and *Marine Biodiversity Records*. However, few journals have set best practice rules for new biogeographical records.

Whatever the cause, several erroneous “new records” have been published in scientific journals (cf. Bello *et al*.,

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2012). Unless these erroneous records are readily emended, they may be cited as good records in subsequent papers and therefore incorrectly confirmed, making it difficult to remove them from faunal guides. For example, 12.3% of the 1396 species (i.e. 172 species) recorded in the Red Sea are indeed misidentifications or other kinds of errors (Golani and Bogorosky, 2010). These wrong data were included in the two editions of CLOFRES (Dor, 1984; Goren and Dor, 1994) for more than 20 years. Also, in the Mediterranean Sea, *Epinephelus tauvina* (Forsskål, 1775) was recorded by Ben-Tuvia and Lourie (1969) and followed by Ben-Tuvia (1971; 1978) and Por (1978). Unfortunately, this occurrence was based on the misidentification of specimens of *E. coioides* and *E. malabaricus* (Heemstra and Golani, 1993).

The present paper was prompted by the publication of a patently mistaken "new record" (Bello *et al*., 2012). Here, we discuss methods to report new information about the distribution of marine organisms, especially fishes, and propose a set of recommendations to improve the accuracy and reliability of published data when producing faunal lists and recording species range expansions. Indeed, the report of species at specific sites is probably the most basic data in ecology (Gaston and Blackburn, 2000).

SITUATION ACCOUNT

With the aim of producing sound biogeographic information, Morović (1973) was possibly the first author to propose rules for publishing records of fishes. He suggested definitions for degrees of rarity: "If a species has been found only once in the last hundred years, it should be considered an exceptionally rare fish; very rare, when it has been recorded three to five times; rare, if it has been reported up to ten times; relatively rare species are those that can be caught not often in one part of the Adriatic Sea." More importantly, Morović (1973) stressed that "First records of fish should be safely published only after a detailed examination of the hitherto published lists of fishes for any specific area."

Some scientific journals also set up rules for acceptance of "first records" in any geographic area. For instance, the Instructions for authors of the International Journal of Ichthyology *Cybium* state, since 1999, that reports of "first records" must include a localization map of the capture, the registration numbers for any specimens deposited in national or otherwise recognized collections, the main morphometric and meristic characters of the specimen(s) and, where possible, a good photograph of the specimen (colour or black and white print) (Anonymous, 1999).

The need for these rules arose from the publication of mistaken identifications. They aim to secure the correct identification and classification of the specimens discussed in the paper. For instance in the first years of the Italian national demersal survey carried out in the second half of the 1980s and beyond, each of the 11 operating units produced lists of netted fish and other animals (mostly cephalopods and commercial crustaceans). Some lists included a few quite improbable fish species, so that the late Enrico Tortonese urged the marine biologists involved in the survey to keep voucher specimens of collected fish in museums (Tortonese, pers. com.), which is in agreement with *Cybium* instructions for "first records" reports.

The above reported rules, while very useful, still miss an important element: whether the piece of information is indeed an actual "first record", viz. the species taken into account had not been reported in that given area previously. In a sense, this issue should not need to be addressed by scientific journal editors, since the author of the record is responsible for its accuracy. However, in the light of recent problems with such cases, it appears that this side of the matter cannot be dismissed altogether by the editors.

Due to the increasing awareness on erroneous fish identifications, the concept of "documented record" was suggested by different authors (Winston, 1999; Herbert *et al*., 2003) and adopted by databases of biodiversity (e.g. GBIF, and their scientific users), which are consulted by scientific institutions and organisations. Those authors suggested that the reported occurrence of any specific organism is to be documented by its photograph, and preferably also by preserved museum voucher specimens. However, this concept may mislead some workers to judge an occurrence sufficiently documented only when it is supported by a photograph (in modern times) or by a preserved museum specimen, and might induce them to discount all the scientific reports devoid of such support. This conduct would pose a great problem, since most of the older established information would be unacceptable according to the above guidelines.

While these older reports must still be considered in contemporary biogeographic studies, we need to be more accurate and vigilant methodologically in the future. Incidentally, misleading incorrect information might be constructed anyway using photographs of genuine specimens (or even using the specimens themselves) whose locality information has been accidentally or even deliberately misrepresented (Talent, 1989) and well-built frauds may also deceive editors and reviewers (McCabe and Wright, 2000).

PROPOSAL

In order to prevent in the future cases of erroneous "first record" reports (cf. Bello *et al*., 2012), which both weaken the stability of biogeographic studies and fail to respect the efforts exerted by colleagues producing faunistic lists, we propose a set of recommendations to be followed by authors

Table I. - Recommendations for the publication of first records in ichthyology.

A	**Corroboration of first record status through examination of available information**
A1	Classify fish according to Catalog of Fishes (Eschmeyer and Fricke, 2013)
A2	Inspect catalogues: (i) regional, (ii) general catalogues
A3	Inspect occurrence databases (collections, atlas)
A4	Inspect museum collection lists and, when relevant, their collections
A5	Inspect all other available databases
B	**Treatment of first record material and related data**
B1	Take accurate photograph(s) of specimen(s) and provide it (them)
B2	Take main meristic and morphometric characters of specimen(s) and report them
B3	Cite reference(s) of paper(s) used to identify specimen(s)
B4	Determine genetic sequence(s) for specimen(s) and make it (them) available in public sequence databases
B5	Deposit voucher specimen(s) in official collections and report its (their) catalogue number(s)

for publications in scientific journals. The recommendations may be subdivided into two groups (Tab. I): the first one addresses the corroboration of the authenticity of the first record status; the second one deals with the presentation of adequate material and related data to support the identification of the specimen(s) being reported.

A. Corroboration of first record status through examination of available information

1. The Catalogue of Fishes (Eschmeyer and Fricke, 2013) provides the most up-to-date information on the classification and nomenclature of most species, and must be checked. This database usually covers divergent opinions on fish taxonomy and selects the best-supported and most recent taxonomic review. While all scientists might not agree with it, it represents the most authoritative and easily available reference (see also Harrison *et al*., 2011).

2. The second step should be the thorough inspection of catalogues and checklists: first the local or regional catalogues and checklists, and then the general ones. For the Mediterranean Sea, the following catalogues and check-lists, for example, should be checked first: Hureau and Monod, 1973a, b; Whitehead *et al*., 1984, 1986; Fischer *et al*., 1987; Papaconstantinou, 1988; Jardas, 1996; Bilecenoglu *et al*., 2002; Golani *et al*., 2002, 2006; Golani, 2005; Louisy, 2005; Duran, 2007, 2010; Relini, 2008, 2010; Golani and Golani-Appelbaum, 2010. For other regions not covered by the aforementioned list, guides and catalogues are generally available as well (CLOFFSCA, Reis *et al*., 2003; CIESM, Golani *et al*., 2002).

3. It is important to distinguish data available in online knowledge bases like catalogues (by taxonomic group or by geography) (e.g. ANTABIF, Danis *et al*., 2013) from occurrence databases (collections, atlas). Indeed, many misidentifications and errors in localities or surveys depend on occurrence descriptions while knowledge bases (catalogues) represent a more integrated level of information. Nevertheless, checking occurrence databases is necessary. The amount of time spent can be high, but these represent the data the catalogues are based on, and it is very important that such datasets are checked and reviewed.

4. While GBIF and FishBase (Froese and Pauly, 2013) now include a large amount of informations from museum's collection catalogues (and so should be consulted as part of step (2) above), not all museum collections provide information on and listings of their specimens in online databases. However, specimens from museum collections can be useful for comparative purposes, especially for the specimens conserved in local collections such as marine stations and local Museums for instance. In consequence, investigations should include an attempt to check these unpublished data. This should definitely include a survey of national collections and Museums; however specimens conserved in local collections such as marine stations and local Museums may be particularly important for regional studies.

5. Authors should be as comprehensive as possible in checking databases and other sources as outlined above, even if the datasets included in them may be the same or overlapping. In reality, updates are not made in a same place in all the databases, and the information might not be synchronised, due to different data managers, institutions, etc. (Catalog of Fishes, Fish Base, GBIF, collection catalogues,…).

B. Treatment of first record material and related data

1. Whenever possible, provide at least one accurate photograph of the specimen (this is critically important if no voucher specimens were collected). Good guidelines for specimen photography are given in several papers (e.g. Steinke and Hanner, 2011).

2. Provide the main meristic and morphometric characters of the specimen(s) to support the correct identification and cite the publication used to determine which characters were measured.

3. Cite the reference(s) used to identify the specimens, in particular the reference of identification keys if used, and the reference of the species description and diagnosis used

(hopefully, these are the same references, but not necessarily).

4. Whenever possible determine the genetic sequence for the specimen for a well-referenced identification marker, for instance and in order of preference cytochrome oxidase 1 (COI, the Barcode of Life reference marker for animal species: Herbert *et al*., 2003), cytochrome b or 12S/16S rDNA. The sequence must then be made available in one of the large public sequence databases, the European Molecular Biology Laboratory database (EMBL), GenBank Data Libraries (GenBank) or the DNA Data Bank of Japan (DDBJ) (Harrison *et al*., 2011) including all the significant specimen information. When relevant (COI sequences), the sequence and specimen data should be deposited in the Barcode of Life Database (BOLD). This database is specifically designed to keep the link between voucher and specimen, and also accepts photographs (Ratnasingham and Herbert, 2007). From BOLD, it is possible to transfer the sequence easily in GenBank, but BOLD makes it easier for users to replace the specimen in a larger sequence dataset. BOLD also has helpful sequence analysis features (Ratnasingham and Herbert, 2007). For less straightforward cases, it may be important to compare the sequence to other available sequence data (for example, where morphological diagnoses are problematic, or where there is a specific need to compare intraspecific genetic variation). The results of the comparison should be described in the paper along with the sequence accession number.

5. List all specimen vouchers, after checking the most updated classifications (Harrison *et al*., 2011; Eschmeyer and Fricke, 2013), with identifying catalogue numbers. These must be deposited in well-maintained and accessible collections that meet Recommendations 72F.1-5 of the International Code of Zoological Nomenclature (ICZN, 2013) for institutional responsibility (see also Harrison *et al*., 2011). In cases where the first record is based on only one specimen, parts from that specimen, such as skeletons, otoliths, head, should not be deposited in a collection separately from the specimen itself. In some cases, it is impossible to preserve a voucher (for example when the specimen is only observed by fieldworkers but cannot be collected or its size and/or condition prevent its preservation). Photographic documentation is even more important in such cases (see B1 above).

DISCUSSION

The best practice proposed in this paper is the first attempt to establish a methodology for publishing new records of fishes. It takes advantage of the large number of, often comprehensive, databases accessible by the internet.

As stated in the Introduction, this proposal was prompted by the publication of erroneous “first records”. In this respect, the peer-review system is also accountable for such incorrect publications. The role of scientific editors remains of paramount importance since it is their duty to select reviewers truly knowledgeable in the regional diversity of a given taxon (which may be a difficult task owing to the declining availability of taxonomic expertise). In turn, the reviewers should have a deep and up-to-date knowledge of the available published material concerning the taxon (or taxa) dealt with in the MS they are asked to review. Whether the proposal reported in the present paper is directly implemented by journals or not, its guidelines are a convenient tool for both editors and reviewers to assess the quality of the data submitted for publication.

The content of this paper deals mainly with the Mediterranean ichthyofauna. Of course the reference to this region is meant as an example of the worldwide situation, hence we recommend other journals dedicated to other regions to produce their own geographical instantiations.

When publishing new records, a foremost role is played by regional taxonomic catalogues (see the many checklists and catalogues listed in the recommendations above); these, provide one of the best ways of checking the validity of first records. Hence, we take the opportunity to advocate the publication of regional taxonomic lists in a valid and available format (for instance in the sense of the International Code of Zoological Nomenclature; ICZN, 2013). The production of new checklists for poorly documented taxa and/or geographic areas, as well as the updating of existing checklists, should be carried out by experienced specialists, preferably in association with authoritative organizations to vouch for their reliability. Such organizations include scientific institutions, recognized associations (e.g. the Italian Society of Marine Biology and the Marine Biological Association of the United Kingdom), and governments. These regional lists should represent the official reference baseline for further research, and for maximal diffusion and usefulness they should be made available freely, either through open-access publishing or on permanent websites in institutional knowledge databases (FishBase Fishwatchers, list.org.br, GBIF). Several good examples of regional checklists and catalogues are mentioned in the present paper. In addition, active biodiversity information systems (e.g. FishBase) might also expand their set of information and provide a tool to check catalogues by area. Further details, such as the publication format of the biogeographic checklists and the responsibility for their scientific soundness, fall beyond the purpose of this paper.

The matter of correct records concerns other taxonomic groups as well. Specialists of some taxa have tackled this problem, e.g. Janni and Fracasso (2010) for ornithofauna, whose survey involves many amateur bird-watchers. To the best of our knowledge, no definitive rules have been established or proposed for most marine taxa. Hence we recommend that specific proposals for recording new geographical occurrences of marine species are put forth by expert taxonomists taking into account the peculiarities of each taxon.

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